Amendments to the Specification

The paragraph starting at page 1, line 1 and ending at line 4 has been amended as follows.

This application claims priority from Japanese Patent Application Nos. 2003-024917 filed January 31, 2003 and 2003-024918 filed January 31, 2003, which are incorporated ~~hereinto~~ herein by reference.

The paragraphs starting at page 1, line 10 and ending at line 22 have been amended as follows.

The present invention relates to a printing apparatus that uses a print head to print an image including characters on a print medium such as a printing sheet as it is transported, and more particularly to a printing apparatus in which a drive source for transporting the print medium is also used as a drive source for a print head performance recovery operation for ~~maintain~~ maintaining the function of the print head.

The present invention also relates to a piston pump which drives a piston by a rotary drive force, and more particularly to a piston pump which is suitably applied to a recovery operation for ~~maintain~~ maintaining the function of the print head in the printing apparatus demanded for size reduction and portability.

The paragraph starting at page 1, line 26 and ending at page 2, line 9 has been amended as follows.

As personal computers, word processors and ~~facsimiles~~ facsimile machines have come into widespread use in offices in recent years, various kinds of printing apparatus are being offered as information output devices for these ~~equipments~~ equipment. Among these output devices, printing apparatus such as ink jet printers (ink jet printing apparatus) that print images including characters by ejecting ink onto a print medium are well balanced in terms of image quality, print speed, apparatus size and price, and can easily be modified to produce color images. Because of these advantages, ink jet printers are in wide use in a variety of fields.

The paragraphs starting at page 3, line 9 and ending at page 4, line 16 have been amended as follows.

A recovery unit 600 maintains a stable ink ejection performance of the ink jet print head 500 by removing viscous ink and dirt adhering to nozzle openings of the ink jet print head 500. The recovery unit 600 has a capping unit 601, a wiping mechanism and a suction mechanism to prevent drying and evaporation of ink ~~form~~ from the nozzle openings of the ink jet print head 500. The capping unit 601 has a cap to cap a surface of

the ink jet print head 500 formed with nozzle openings (referred to as a "nozzle face") when it is not printing. The wiping mechanism removes ink adhering to the nozzle face of the ink jet print head 500 as by a blade. The suction mechanism sucks out viscous ink from the nozzles of the ink jet print head 500 and nearby portions through the cap of the capping unit 601. The suction mechanism introduces a negative pressure from a pump into the cap engaging the nozzle face to draw out waste ink not contributing to the printing of ~~image~~ images from the nozzles ~~out~~ into the cap.

Such a conventional printing apparatus, as described in Patent References 1 and 2 (listed below), is known to have a construction in which a plurality of drive mechanisms are driven by a second drive source separate from the drive source for the print head mounting carriage and in which a proper driving force from the second drive source is selected for output according to the position of the moving carriage. For example, in the case where a recovery mechanism and a sheet feeding mechanism are driven by the second drive source, the second drive source is selected for output to these mechanisms according to the position of the moving carriage or a registration operation during sheet feeding is activated or deactivated according to the position of the moving carriage. Patent Reference 3 discloses a construction in which the cap in the recovery unit is slid to open and close the nozzle face according to the movement of the carriage.

The paragraph starting at page 6, line 7 and ending at line 16 has been amended as follows.

Printing apparatus with functions of printers, copying machines and ~~facsimiles~~ facsimile machines, and printing apparatus used as output devices for composite electronic devices including computers and word processors and for workstations are constructed to form images on print mediums (recording medium) such as paper, thin plastic sheets, etc., according to image information. These printing apparatus may be classified into an ink jet system, a wire dot system, a thermal system and a laser beam system according to the printing method employed.

The paragraph starting at page 22, line 21 and ending at line 26 has been amended as follows.

The automatic paper feed unit 100 of this embodiment horizontally feeds print sheets stacked at an angle of about 30-60 degrees to a horizontal plane. While keeping the print sheet in the almost horizontal attitude, the automatic paper feed unit 100 feeds it from the supply port (not shown) to the transport unit 200.

The paragraph starting at page 23, line 11 and ending at page 24, line 3 has been amended as follows.

In front of the pressure plate 103 a paper feed roller shaft 108 is rotatably supported and is rotated by an AP motor 107 through a plurality of transmission gears, i.e., ~~a~~ an AP gear a 116, ~~a~~ an AP gear b 117 and a paper feed roller gear 115. The paper feed roller shaft 108 is securely attached with two paper feed rollers 101 D-shaped in ~~cross section~~ cross-section. As the paper feed rollers 101 are rotated by the AP motor 107, the print sheets stacked on the pressure plate 103 are fed one sheet at a time, beginning with the uppermost sheet. That is, the uppermost sheet of the stacked print sheets is separated one by one by a frictional separation action produced when the sheet rides over the separation seats 104, and then fed in the direction of arrow A to the transport unit 200. The pressure plate 103 is elastically supported on the chassis 701 by two pressure plate springs 105 at both ends of the pressure plate 103 which are interposed between the pressure plate 103 and the chassis 701 (see Fig. 1). The contact pressure between the paper feed rollers 101 and the print sheet is kept at an optimum value for an allowable range of stacked sheets.

The paragraph starting at page 25, line 1 and ending at line 11 has been amended as follows.

After the paper feed operation by the automatic paper feed unit 100 is completed, planar portions X of the paper feed rollers 101 D-shaped in ~~cross-section~~ cross-section are almost parallel to the pressure plate 103 and the pressure plate 103 ~~are~~ is parted from the paper feed rollers 101 by two pressure plate cams 111 provided on the paper feed roller shaft 108. An ASF sensor cam 112 is provided on the paper feed roller shaft 108. The orientation of the planar portions X in the paper feed rollers 101 D-shaped in ~~cross section~~ cross-section can be controlled by an ASF sensor switch 113 detecting a phase of the ASF sensor cam 112.

The paragraph starting at page 26, line 12 and ending at line 27 has been amended as follows.

The paper feed rollers 101 may rotate simultaneously with the LF roller 201 for a margin of the feed distance. In that case, the print sheet P is fed downstream in the transport direction by the coordinated action of the paper feed rollers 101 and the LF roller 201 for a predetermined duration. Then, after the rotation of the paper feed rollers 101 is completed, the LF roller 201 is rotated forward or backward as necessary to feed the print

sheet P to the print start position. The printing unit 400 (described later) now prints a first part of an image, after which the LF roller 201 is rotated to feed the print sheet P a predetermined distance. The printing unit 400 again prints a subsequent part of the image. By alternating these operations – printing an image and feeding the print sheet a predetermined distance – an image is formed on the print sheet P supported on the platen 203.

The paragraph starting at page 28, line 15 and ending at line 25 has been amended as follows.

The carriage 401 has a head connector (not shown) which is electrically connected to a carriage FPC (flexible printed circuit board) 404. The head connector, when connected with external input signal terminals provided in the print head cartridge 501, sends and receives a variety of information for printing and also supplies electric power to the print head. The carriage FPC 404 is drawn out of the carriage 401 for electrical connection with a main printed circuit board (not shown) in the apparatus body. The carriage FPC 404 on the carriage 401 also has an encoder sensor 407.

The paragraph starting at page 29, line 25 and ending at page 30, line 6 has been amended as follows.

Between the side surfaces of the chassis 701, the guide shaft 402 and the guide rail 305 are arranged parallel to each other. The carriage 401 is movably guided along the guide shaft 402 and a rail portion provided on the guide rail 305. As a result, the carriage 401 is supported ~~movable~~ movably in the main scan direction which is perpendicular to the transport direction of a print medium (which includes a flexible printable sheet, such as a plastic sheet) and parallel to a print surface of the print medium.

The paragraphs starting at page 42, line 3 and ending at page 43, line 20 have been amended as follows.

Fig. 32 is a partly cutaway ~~cross section~~ cross-section showing a state in which the piston shaft 626 has moved in the direction of arrow PA from the position of Fig. 31 so that the piston 625 has passed the position of the suction port 630. As the piston shaft 626 moves in the direction of arrow PA, the piston 625 comes into intimate contact with the closed flange portion 632, isolating the first chamber 628 and the second chamber 629 from each other. As the second chamber 629 is compressed, a positive pressure is generated, discharging the ink therein (not shown) from the discharge port 631. Since the

first chamber 628 is expanded, a negative pressure is produced therein, causing ink to be sucked from the suction port 630.

Fig. 33 is a partly cutaway ~~cross-section~~ cross-section showing a state in which the piston shaft 626 has further moved in the direction of arrow PA from the position of Fig. 32 and the piston 625 has reached a bottom dead point. In the state of Fig. 33, the volume of the second chamber 629 is minimum and the volume of the first chamber 628 is maximum, completing the suction and discharge operations.

Fig. 34 is a partly cutaway ~~cross-section~~ cross-section showing a state in which the piston shaft 626 has moved some distance in the direction of arrow PB from the bottom dead point of Fig. 33. As the piston shaft 626 moves in the direction of arrow PB, the piston 625 comes into intimate contact with the piston stopper 634. The first chamber 628 and the second chamber 629 communicate with each other through the clearance between the outer circumferential surface of the piston shaft 626 and the inner circumferential surface of the piston 625 and through the communication grooves. In this state, as the piston shaft 626 moves in the direction of arrow PB, the second chamber 629 is expanded producing a negative pressure and the first chamber 628 is compressed producing a positive pressure. A flow resistance of the suction port 630 is set higher than a flow resistance of a space ranging from the clearance between the outer circumferential surface of the piston shaft 626 and the inner circumferential surface of the piston 625 to the communication grooves. Thus, a pressure difference between the first chamber 628 and

the second chamber 629 causes the sucked ink in the first chamber 628 to flow into the second chamber 629 from the clearance between the outer circumferential surface of the piston shaft 626 and the inner circumferential surface of the piston 625 through the communication grooves.

The paragraph starting at page 50, line 15 and ending at page 51, line 5 has been amended as follows.

Thus, rotating the control ring 637 at a fixed position in the direction of arrow b causes the boat-shaped piece 638 to rotate together with the control ring 637 in the direction of arrow b while keeping its protruding portion in sliding engagement with the groove 626A in the piston shaft 626. So, the protruding portion of the boat-shaped piece 638 moves relative to the piston shaft 626 along the groove 626A. As a result, the boat-shaped piece 638, while sliding along the groove 626A, pushes the piston shaft 626 reciprocally in the direction of arrows A1, B1. That is, as the boat-shaped piece 638 continuously rotates together with the control ring 637 in the direction of arrow ~~b~~, b, the protruding portion of the boat-shaped piece 638 continuously moves along the groove 626A, causing the piston shaft 626 to reciprocate in the direction of arrows A1, B1. At this time, by detecting the position of the piston shaft 626 by a sensor, it is possible to control the amount of ink to be sucked by the piston pump 640.

The paragraphs starting at page 52, line 24 and ending at page 53, line 21 have been amended as follows.

Fig. 32 is a ~~cross-section~~ cross-section showing a state in which the piston shaft 626 has moved in the direction of arrow A1 from the position of Fig. 31 so that the piston 625 has passed the position of the suction port 630. As the piston shaft 626 moves in the direction of arrow A1, the piston 625 comes into intimate contact with the closed flange portion 632, isolating the first chamber 628 and the second chamber 629 from each other. As the second chamber 629 is compressed, a positive pressure is generated, discharging the ink therein (not shown) from the discharge port 631. Since the first chamber 628 is expanded, a negative pressure is produced therein, causing ink not contributing to image printing to be sucked from the nozzles of the print head through the suction port 630 (suction-based recovery operation).

Fig. 33 is a ~~cross-section~~ cross-section showing a state in which the piston shaft 626 has further moved in the direction of arrow A1 from the position of Fig. 32 and the piston 625 has reached a bottom dead point. In the state of Fig. 33 the volume of the second chamber 629 is minimum and the volume of the first chamber 628 is maximum, completing the suction and discharge operations.

Fig. 41 is a ~~cross-section~~ cross-section showing a state in which the piston shaft 626 has moved slightly from the bottom dead point of Fig.33 in the direction of arrow B1.

The paragraph starting at page 56, line 8 and ending at line 13 has been amended as follows.

The ink jet print ~~head~~ apparatus can use various types of print ~~head~~ heads which, for example, employ electrothermal transducers or piezoelectric elements. When electrothermal transducers are used, bubbles are generated in ink by thermal energy they produce and the expanding pressure of the bubbles is used to eject ink droplets from the nozzles.

The paragraph starting at page 56, line 17 and ending at line 24 has been amended as follows.

The present invention has been described in detail with respect to preferred embodiments, and it will now be apparent from the foregoing to those skilled in the art that changes and modifications may be made without departing from the invention in its broader ~~aspect~~ aspects, and it is the intention, therefore, ~~in~~ that the ~~apparent~~ appended claims ~~to~~ cover all such changes and modifications as fall within the true spirit of the invention.